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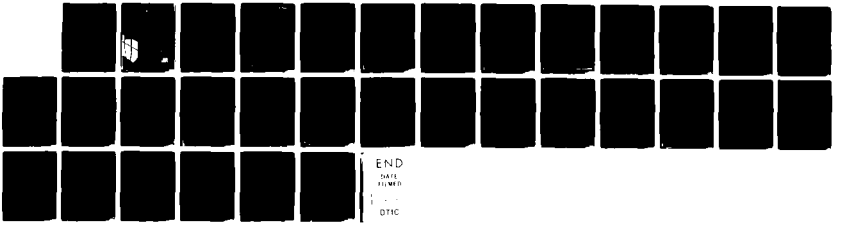
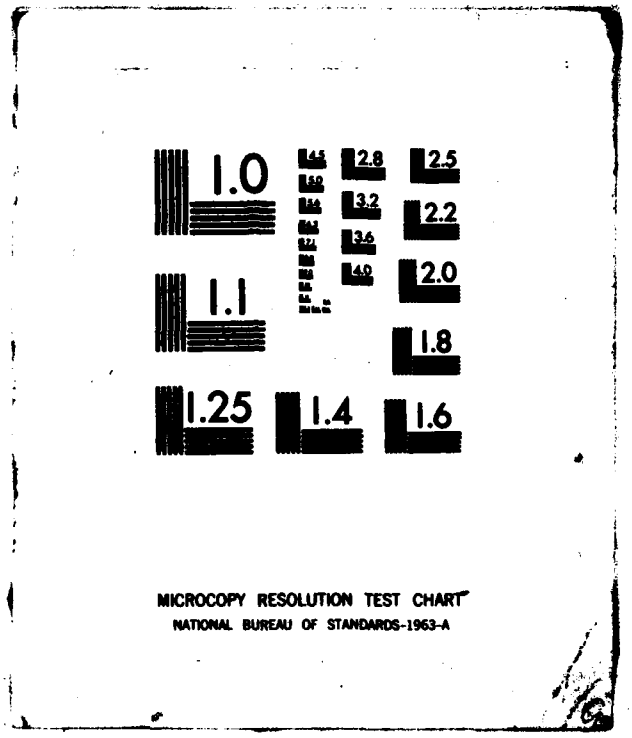
SYSTEM: USER'S MANUAL(U) CONSTRUCTION ENGINEERING
RESEARCH LAB (ARMY) CHAMPAIGN IL D G BAGBY ET AL.
UNCLASSIFIED OCT 82 CERL-TR-P-135 F/G 13/2 NL

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1.8
MICROCOPY RESOLUTION TEST CHART
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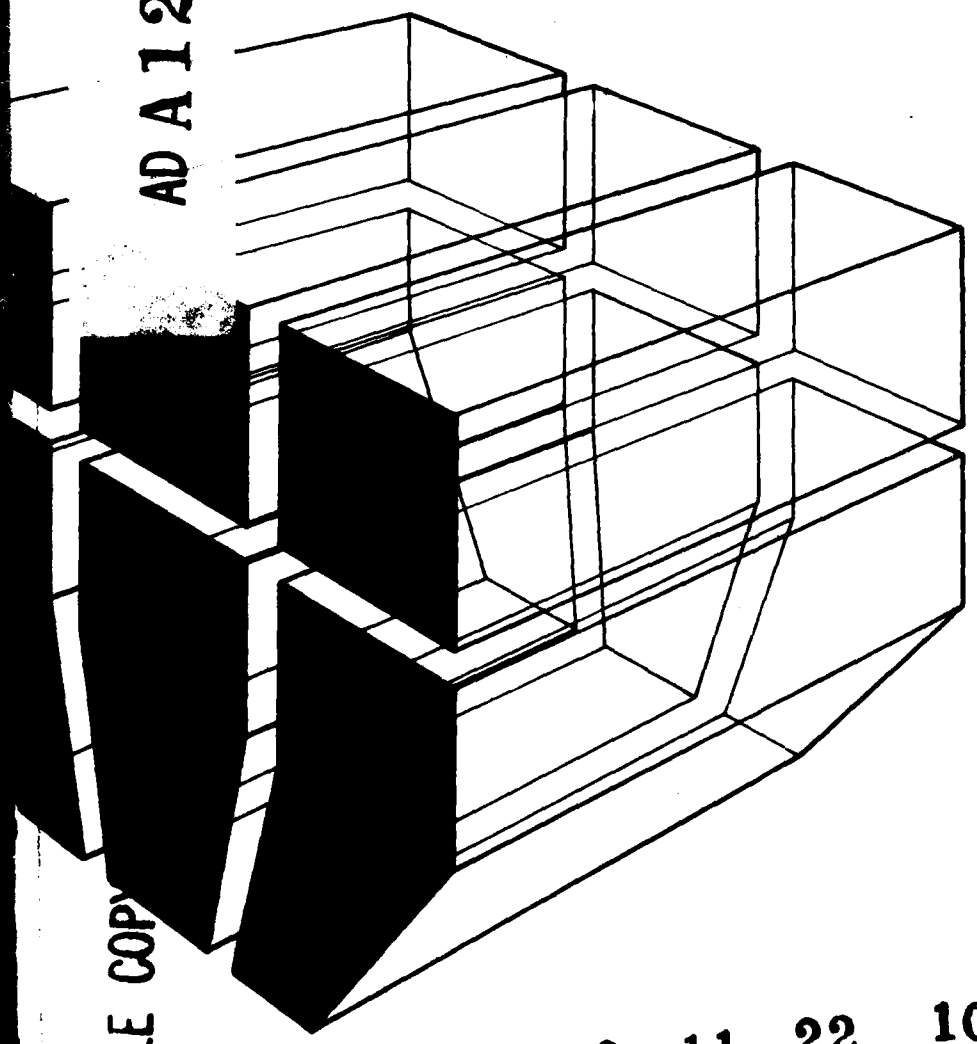
TECHNICAL REPORT P-135
October 1982

AD A121661

COMPUTERIZED CIVIL WORKS CONSTRUCTION COST INDEX SYSTEM: USERS' MANUAL



by
D. Gordon Bagby
Shahid Siddiqi

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construction

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Costs for U.S. Army Corps of Engineers civil works projects are first estimated before concept designs are prepared. These projects are not immediately authorized for construction; in fact, it may be several years before appropriations are made for even the detailed design phase. During this time, inflation usually makes the current costs higher than previously estimated.

For programming requirements, the estimates must be updated annually. Corps districts can do this in two ways: (1) performing a detailed re-

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estimate, or (2) applying an inflation factor to the latest estimate. Both methods have advantages and disadvantages. Re-estimating gives results that are at least as accurate as the prior estimate, but it is very time-consuming and is therefore not practical to do annually because of the limited number of personnel available at the district level. Updating using an inflation factor can be done very quickly, with acceptable accuracy.

The U.S. Army Construction Engineering Research Laboratory (CERL) has developed a system of indices -- the Civil Works Construction Cost Index System (CWCCIS) -- specifically for updating civil works construction costs before the official Government estimate for contract award. The Office of the Chief of Engineers asked CERL to computerize this system so that the calculations needed to change index values and update estimates could be done automatically. This report provides instructions for users of the computerized CWCCIS.

FOREWORD

This study was done for the Directorate of Civil Works, Office of the Chief of Engineers (OCE), under IAO CWE-BA-81-11. The OCE Technical Monitor was E. B. Wilsie, DAEN-CWE-BA.

The Facilities Systems Division (FS), U.S. Army Construction Engineering Research Laboratory (CERL), did this study. Mr. E. A. Lotz is Chief of CERL-FS.

COL Louis J. Circeo is Commander and Director of CERL, and Dr. L. R. Shaffer is Technical Director.

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COMPUTERIZED CIVIL WORKS CONSTRUCTION COST INDEX SYSTEM: USERS' MANUAL

1 INTRODUCTION

Background

The costs for U.S. Army Corps of Engineers civil works projects are first estimated before concept designs are prepared. These projects are not immediately authorized for construction; in fact, it may be several years before appropriations are made for even the detailed design phase. During this time, inflation usually makes the current costs higher than previously estimated.

For programming requirements, the estimates must be updated annually. Corps districts can do this in two ways: (1) performing a detailed re-estimate, or (2) applying an inflation factor to the latest estimate. Both methods have advantages and disadvantages. Re-estimating gives results that are at least as accurate as the prior estimate, but it is very time-consuming and is therefore not practical to do annually because of the limited number of personnel available at the district level. Updating using an inflation factor can be done very quickly, with acceptable accuracy.

The U.S. Army Construction Engineering Research Laboratory (CERL) has developed a system of indices -- the Civil Works Construction Cost Index System (CWCCIS) -- specifically for updating civil works construction costs before the official Government estimate for contract award.[1] (The appendix explains the principles of cost indexing.) The Office of the Chief of Engineers asked CERL to computerize this system so that the calculations needed to change index values and revise estimates could be done automatically.

Objective

The objective of this report is to provide instructions for users of the computerized CWCCIS.

Approach

CERL's experiences with CWCCIS and with field testing of the computerized system were used to develop the procedures described in this report.

---

[1] U. R. Poskus, Civil Works Construction Cost Index System (CWCCIS), Technical Report P-85/ADA048102 (U.S. Army Construction Engineering Research Laboratory [CERL], 1977).

Mode of Technology Transfer

It is recommended that the information in this report be incorporated in Engineer Manual (EM) 1110-2-1301, Engineering and Design: Cost Estimates — Planning and Design Stages.

2 USING THE COMPUTERIZED CWCCIS

This chapter explains how to access and use the CWCCIS interactive system, which resides on Boeing Computer Service's (BCS's) EK3-1 subsystem, a bank of Cyber 175 computers. To keep the computerized CWCCIS current, the Office of the Chief of Engineers updates the cost information used by the system.

System Overview

The computerized CWCCIS is used on interactive, remote terminals available at all Corps districts and divisions. To access CWCCIS, the user signs on with his/her account and password; the program then gives instructions about operating the system. (Experienced users may bypass the explanation and proceed immediately to requesting information.) The user provides information about the type of cost index report and time period he/she wants. The computer lists the costs for the project, breaking them down by component (e.g., labor, cement, steel). If the user wants to determine the probable costs of a project planned for the future, he/she can request a cost projection for the future date.

Table 1 is a cross-referenced list of the files and programs or procedures CWCCIS requires when a user wants to compute cost indices. The first

Table 1

Cross-Reference for Programs and Files

Program/File Name	Function	Programs Which Use This File
COSTIND	Procedure user calls to compute project cost indices.	COSTIND
CWCI	FORTRAN source used by COSTIND.	CWCI COSTIND
BCWCI	Binary compilation of CWCI for actual execution by COSTIND.	BCWCI COSTIND
WEIGHT	Data file containing the weighted proportions of earth, concrete, etc., required for each project. The format used is: 14X,5F7.4.	WEIGHT COSTIND CWCI BCWCI
HELPCI	A procedure which lists the user introductory help text in file HELPCIT.	HELPCI HELPCIT
HELPCIT	A text file containing a user help facility. This explains how to use the CWCI program and how to input information.	HELPCIT HELPCI

column gives the name of the program or procedure and the permanent file in which it resides. The second column lists the function of the program or describes the data in the file. The third column lists all programs which use the file. The list begins with this file's name, followed by the programs or files it requires.

Accessing Computerized CWCCIS

The user can access computerized CWCCIS by dialing the local or toll-free telephone number supplied with a BCS account. After dialing this number and obtaining the carrier, the user presses the CARRIAGE RETURN (CR) key a few times. The computer responds:

```
welcome to the bcs network
your access port is ciy 039

select desired service:
```

The user types "eks1". The computer responds:

```
82/05/12. 10.37.50.
EKS1 760K.N0501.54 B 82/05/02.DS-0 03.07.52. 82/05/12.

SIGNON:
```

The user enters his/her BCS account sign-on — usually a six-character alphanumeric code. When CR is pressed, the computer responds with:

```
PASSWORD:
```

The user then enters the password associated with the sign-on for his/her account. When the CR key is pressed again, the computer flashes the time (Pacific standard time) and the user's terminal number.* After the terminal number is printed, the computer asks the user to enter a one- to six-character name for identification; the user finishes accessing by typing his/her name and pressing CR.

Getting Help

By typing in "call,helpci/un=cecelb" or "-helpci/un=cecelb", the new user can print out an introduction to the Cyber 175 and instructions for computerized CWCCIS. The HELPCI document describes the use of several keys on the terminal:

1. RETURN or CR: This key is used to tell the computer to accept what has been typed in since the last RETURN or CR.

---

* This number is important because it must be used to continue working if there is a telephone line failure or interruption. For a complete description of the procedure, refer to the Mainstream — EKS Interactive Time Sharing (KIT) Users Manual, published by BCS.

2. CNTRL S: The output is interrupted when these keys are pressed simultaneously. This may be thought of as a pause function.

3. CNTRL Q: When these keys are pressed, the printing of output begins exactly where it stopped when CNTRL S was activated.

4. CNTRL H: When these keys are pressed simultaneously, the computer backspaces, allowing the user to type over errors and continue with the correct input. This is done with the BACKSPACE key on some terminals.

5. ESC or DEL: When one of these keys is pressed, the computer rejects the line just typed. In other words, every character typed in since the last RETURN or CR is rejected. When ESC or DEL is pressed, the computer responds with *DEL*; the user then revises.

Using the System

After the HELPCI document has been printed, the computer responds with READY, which means that it will accept commands. The user then types in "call,costind/un=cecelb" or "-costind/un=cecelb". This calls up the interactive COSTIND procedure, which prompts the user for all input needed in the index calculations.

Note: The user is first asked to enter the code for the type of terminal he/she is using (e.g., see Figure 1). If this terminal is not listed, the ALP code can be used for any device.

COSTIND allows the user the following options in calculating cost indices:

1. The cost index of just one construction feature (Table A1) for a given quarter and year.

2. The cost indices for a given quarter and year for all 19 construction features.

3. The cost index for a given quarter and year for one particular feature, and a projection of that index for a future quarter and year. (The output includes a graph of the cost trend; this is available both on graphics and alphanumeric terminals.)

4. The cost indices for all 19 features and a projection of these indices for a future quarter and year.

For options 2 and 4, pie charts displaying the relative size of each index are available if the user types "pie" when prompted by the program. Users on nongraphic terminals should avoid these options because they take too much time on such equipment. For option 4, two pie charts are displayed — one for the present quarter and one for the future quarter and year for which indices are projected. With option 2, only the pie chart for the present quarter is displayed.

Option 3 projects the cost index for future years by using a linear least squares fit. The index is extrapolated along a straight line plotted through the past 12 quarters of index data.

Figures 1 through 4 are examples of the outputs corresponding to the four options above. All the user input is shown in lower-case letters; the output produced by the computer is in upper-case letters. The user input always appears after the symbol I>, which the computer prints to prompt the user.

If there are problems during the program, type in "stop"; this will terminate any instruction the computer is executing. The machine will respond *TERMINATED*, and the user can start again.

Logging Out

When the user is finished, he/she types "bye" and presses the CR key. The computer then logs out the user and responds with the charges for the session. If the user logs out by mistake, he/she can sign on and start again.

```
IDLE.
C>-costind/un=cecelb
 12.35.31. WHEN ASKED FOR "DEVICE-" PRESS RETURN KEY TO GET A LIST
 12.35.31. OF DEVICES TYPES AVAILABLE. THEN TYPE IN APPROPRIATE TYPE
 12.35.31. OF DEVICE EXACTLY AS WRITTEN IN THE LIST OF DEVICES.
 12.35.31. FOR HELP CALL SIDDIQI, U OF ILL. 217-333-3146.
 DEVICE-
I>
 LEGAL DEVICE CODES ARE:
 ALP - ALPHANUMERIC TERMINALS (80 COLS)
 C93 - CALCOMP 935 PLOTTER
 PTR - LINE PRINTER (120 COLS)
 RJE - REMOTE PLOTTING
 TEK - TEKTRONIX 4010/4013 TERMINALS
 TK4 - TEKTRONIX 4014/4015 TERMINALS
 T27 - TEKTRONIX 4027 TERMINAL
 T62 - TEKTRONIX 4014/4015 TERMINALS & TEKTRONIX 4662
 T63 - TEKTRONIX 4014/4015 TERMINALS & TEKTRONIX 4663
 T41 - TEKTRONIX 4114 TERMINAL
 DR4 - TEKTRONIX 4014/4015 TERMINALS & CALCOMP PLOTTER
 DEVICE-
I>alp

WELCOME TO THE CERL CIVIL WORKS COST COMPUTING INDEX
PROGRAM DESIGNED BY SIDDIQI & STAMAS OF CERL CHAMPAIGN, ILL
TYPE IN THE DESIRED INPUT AFTER THE COMPUTER TYPES:

I>

IF YOU MAKE A MISTAKE PRESS THE CONTROL KEY & H SIMULTANEOUSLY
THIS WILL BACK SPACE YOU & ALLOW YOU TO OVERWRITE CHARACTERS
IF YOU WISH TO STOP ANYWHERE TYPE IN -- STOP

TYPE IN THE QUARTER & YEAR DESIRED FOR INDEX CALCULATION
ENTER THESE AS - 1 1976 - TO INDICATE THE 1ST QUARTER OF 1976
(DONT TYPE IN THE -), VALID YEAR CHOICES ARE 1975-1981
THE INDEX IS BASED ON 1967=100
I>1  1981

TYPE IN USER LEVEL, TYPE IN -E- FOR EXPERT USER
THIS ALLOWS YOU TO TYPE ALL INPUTS WITHOUT DETAILED WORDING
IF NOVICE USER TYPE ANY CHARACTER OTHER THAN E
I>tyro

TYPE IN THE TYPE OF PROGRAM OUTPUT DESIRED
TYPE IN - FULL - IF RESULTS AS WELL AS INPUT WEIGHTS DESIRED
TYPE IN WORD - PART - IF ONLY THE RESULTS DESIRED
I>part
```

Figure 1. Output for COSTIND option 1.

```
CHOOSE ONE OF THE FOLLOWING PROJECTS FOR CALCULATION
CHOICE DESIRED MUST BE A PROJECT NO. FROM 1-19 (ON LEFT)
EG. 5 IS POWER PLANTS. IF ALL PROJECTS COST INDICES DESIRED
TYPE IN ANY + NUMBER OTHER THAN 1-19
   1    03   RESERVOIR       •
   2    04A  EARTH DAM       •
   3    04B  CONCRETE DAM    •
   4    05   LOCK            •
   5    07   POWER PLANTS    •
   6    08A  ROADS           •
   7    08B1 CONCRETE BRIDGE•
   8    08B2 STEEL BRIDGE    •
   9    08C  RAIL ROAD       •
  10    09A  CHANNELS & CANALS•
  11    09B  CHANNELS & CANALS•
  12    10   BREAK WATERS    •
  13    11A  LEVEES          •
  14    11B  LEVEES          •
  15    11C  LEVEES          •
  16    13   PUMPING PLANTS  •
  17    15   FLOODWAY CONTROL•
  18    16A  BANK STABILIZATION•
  19    16B  BANK STABILIZATION•
I>1

TYPE IN THE QUARTER & YEAR FOR WHICH YOU WISH TO
PROJECT THE COST INDICES. TYPE THEM IN THE SAME WAY AS BEFORE
EG. 1 1985. DO NOT SPECIFY A YEAR BEYOND 1985
IF NO PROJECTION DESIRED TYPE IN-- 0 0

I>0    0

 CONSTRUCTION COST INDICES FOR QUARTER  1   OF YEAR  1981


 CONSTRUCTION COST INDEX FOR     03   RESERVOIR       •


                LABOR      PLANT  MATERIAL      INDEX
 EARTH        296.097    312.739   283.777    300.009
 CONCRETE       0.000      0.000     0.000      0.000
 STEEL          0.000      0.000     0.000      0.000
 MECHANICA      0.000      0.000     0.000      0.000
 ELECTRICA      0.000      0.000     0.000      0.000

  1  03   RESERVOIR              300.009




   PAUSE   TO CONTINUE TYPE- GO, TO STOP TYPE- STOP
I>go
*
C>
```

Figure 1. (Cont'd).

```
IDLE.
C>-costind/un = CRcelb
 12.41.11. WHEN ASKED FOR "DEVICE-" PRESS RETURN KEY TO GET A LIST
 12.41.11. OF DEVICES TYPES AVAILABLE. THEN TYPE IN APPROPRIATE TYPE
 12.41.11. OF DEVICE EXACTLY AS WRITTEN IN THE LIST OF DEVICES.
 12.41.11. FOR HELP CALL SIDDIQI, U OF ILL. 217-333-3146.
 DEVICE-
I>alp

WELCOME TO THE CERL CIVIL WORKS COST COMPUTING INDEX
PROGRAM DESIGNED BY SIDDIQI & STAMAS OF CERL CHAMPAIGN, ILL
TYPE IN THE DESIRED INPUT AFTER THE COMPUTER TYPES:

I>

IF YOU MAKE A MISTAKE PRESS THE CONTROL KEY & H SIMULTANEOUSLY
THIS WILL BACK SPACE YOU & ALLOW YOU TO OVERWRITE CHARACTERS
IF YOU WISH TO STOP ANYWHERE TYPE IN -- STOP

TYPE IN THE QUARTER & YEAR DESIRED FOR INDEX CALCULATION
ENTER THESE AS - 1 1976 - TO INDICATE THE 1ST QUARTER OF 1976
(DONT TYPE IN THE -), VALID YEAR CHOICES ARE 1975-1981
THE INDEX IS BASED ON 1967=100
I>1 1981

TYPE IN USER LEVEL, TYPE IN -E- FOR EXPERT USER
THIS ALLOWS YOU TO TYPE ALL INPUTS WITHOUT DETAILED WORDING
IF NOVICE USER TYPE ANY CHARACTER OTHER THAN E
I>novice

TYPE IN THE TYPE OF PROGRAM OUTPUT DESIRED
TYPE IN - FULL - IF RESULTS AS WELL AS INPUT WEIGHTS DESIRED
TYPE IN WORD - PART - IF ONLY THE RESULTS DESIRED
I>part.,

CHOOSE ONE OF THE FOLLOWING PROJECTS FOR CALCULATION
CHOICE DESIRED MUST BE A PROJECT NO. FROM 1-19 (ON LEFT)
EG. 5 IS POWER PLANTS. IF ALL PROJECTS COST INDICES DESIRED
TYPE IN ANY + NUMBER OTHER THAN 1-19
   1    03   RESERVOIR       •
   2    04A  EARTH DAM       •
   3    04B  CONCRETE DAM    •
   4    05   LOCK            •
   5    07   POWER PLANTS    •
   6    08A  ROADS           •
   7    08B1 CONCRETE BRIDGE •
   8    08B2 STEEL BRIDGE    •
   9    08C  RAIL ROAD       •
  10    09A  CHANNELS & CANALS•
  11    09B  CHANNELS & CANALS•
  12    10   BREAK WATERS    •
  13    11A  LEVEES          •
  14    11B  LEVEES          •
  15    11C  LEVEES          •
  16    13   PUMPING PLANTS  •
  17    15   FLOODWAY CONTROL•
  18    16A  BANK STABILIZATION•
  19    16B  BANK STABILIZATION•
I>20
```

Figure 2. Output for COSTIND option 2.

```
AS INDICES FOR ALL 19 PROJECTS ARE DESIRED YOU HAVE THE
OPTION OF SKIPING THE INTERMEDIATE DISPLAY OF THE COMPONENTS OF
EACH INDEX. IF YOU WISH TO TAKE THIS SKIP, TYPE IN - - SKIP - -
OTHERWISE TYPE IN ANY OTHER CHARACTER
I>skip

TYPE IN THE QUARTER & YEAR FOR WHICH YOU WISH TO
PROJECT THE COST INDICES. TYPE THEM IN THE SAME WAY AS BEFORE
EG. 1 1985. DO NOT SPECIFY A YEAR BEYOND 1985
IF NO PROJECTION DESIRED TYPE IN-- 0 0

I>0  0

 CONSTRUCTION COST INDICES FOR QUARTER  1   OF YEAR  1981


  THE PROJECT INDICES FOR QUARTER  1 OF YEAR  1981
   1  03    RESERVOIR              300.009
   2  04A   EARTH DAM              291.602
   3  04B   CONCRETE DAM           290.936
   4  05    LOCK                   290.510
   5  07    POWER PLANTS           282.490
   6  08A   ROADS                  293.310
   7  08B1  CONCRETE BRIDGE        290.750
   8  08B2  STEEL BRIDGE           296.299
   9  08C   RAIL ROAD              300.037
  10  09A   CHANNELS & CANA        288.692
  11  09B   CHANNELS & CANA        298.518
  12  10    BREAK WATERS           297.866
  13  11A   LEVEES                 287.678
  14  11B   LEVEES                 303.331
  15  11C   LEVEES                 297.479
  16  13    PUMPING PLANTS         291.550
  17  15    FLOODWAY CONTRO        293.792
  18  16A   BANK STABILIZAT        276.894
  19  16B   BANK STABILIZAT        281.404




   PAUSE   TO CONTINUE TYPE- GO, TO STOP TYPE- STOP
I>go
*
C>
```

Figure 2. (Cont'd).

```
IDLE.
C>-costind/un=cecelb
 12.51.10. WHEN ASKED FOR "DEVICE-" PRESS RETURN KEY TO GET A LIST
 12.51.10. OF DEVICES TYPES AVAILABLE. THEN TYPE IN APPROPRIATE TYPE
 12.51.10. OF DEVICE EXACTLY AS WRITTEN IN THE LIST OF DEVICES.
 12.51.10. FOR HELP CALL SIDDIQI, U OF ILL. 217-333-3146.
 DEVICE-
I>alp

WELCOME TO THE CERL CIVIL WORKS COST COMPUTING INDEX
PROGRAM DESIGNED BY SIDDIQI & STAMAS OF CERL CHAMPAIGN, ILL
TYPE IN THE DESIRED INPUT AFTER THE COMPUTER TYPES:

I>

IF YOU MAKE A MISTAKE PRESS THE CONTROL KEY & H SIMULTANEOUSLY
THIS WILL BACK SPACE YOU & ALLOW YOU TO OVERWRITE CHARACTERS
IF YOU WISH TO STOP ANYWHERE TYPE IN -- STOP

TYPE IN THE QUARTER & YEAR DESIRED FOR INDEX CALCULATION
ENTER THESE AS - 1 1976 - TO INDICATE THE 1ST QUARTER OF 1976
(DONT TYPE IN THE -), VALID YEAR CHOICES ARE 1975-1981
THE INDEX IS BASED ON 1967=100
I>1  1981

TYPE IN USER LEVEL, TYPE IN -E- FOR EXPERT USER
THIS ALLOWS YOU TO TYPE ALL INPUTS WITHOUT DETAILED WORDING
IF NOVICE USER TYPE ANY CHARACTER OTHER THAN E
I>e

TYPE IN, ON 1 LINE, PROJ NO., PROJECTED QUARTER,
PROJECTED YEAR, & ON NEXT LINE, SKIP IF SKIP OPTION DESIRED

I>22       0    0
I>skip
```

Figure 3. Output for COSTIND option 3.

```
CONSTRUCTION COST INDICES FOR QUARTER  1   OF YEAR  1981


 THE PROJECT INDICES FOR QUARTER  1 OF YEAR  1981
  1   03    RESERVOIR              300.009
  2   04A   EARTH DAM              291.602
  3   04B   CONCRETE DAM           290.936
  4   05    LOCK                   290.510
  5   07    POWER PLANTS           282.490
  6   08A   ROADS                  293.310
  7   08B1  CONCRETE BRIDGE        290.750
  8   08B2  STEEL BRIDGE           296.299
  9   08C   RAIL ROAD              300.037
 10   09A   CHANNELS & CANA        288.692
 11   09B   CHANNELS & CANA        298.518
 12   10    BREAK WATERS           297.866
 13   11A   LEVEES                 287.678
 14   11B   LEVEES                 303.331
 15   11C   LEVEES                 297.479
 16   13    PUMPING PLANTS         291.550
 17   15    FLOODWAY CONTRO        293.792
 18   16A   BANK STABILIZAT        276.894
 19   16B   BANK STABILIZAT        281.404



   PAUSE   TO CONTINUE TYPE- GO, TO STOP TYPE- STOP
I>go
*
C>
```

Figure 3. (Cont'd).

```
IDLE.
C>-costind/un=cecelb
 12.27.20. WHEN ASKED FOR "DEVICE-" PRESS RETURN KEY TO GET A LIST
 12.27.20. OF DEVICES TYPES AVAILABLE. THEN TYPE IN APPROPRIATE TYPE
 12.27.20. OF DEVICE EXACTLY AS WRITTEN IN THE LIST OF DEVICES.
 12.27.20. FOR HELP CALL SIDDIQI, U OF ILL. 217-333-3146.
 DEVICE-
I>alp

WELCOME TO THE CERL CIVIL WORKS COST COMPUTING INDEX
PROGRAM DESIGNED BY SIDDIQI & STAMAS OF CERL CHAMPAIGN, ILL
TYPE IN THE DESIRED INPUT AFTER THE COMPUTER TYPES:

I>

IF YOU MAKE A MISTAKE PRESS THE CONTROL KEY & H SIMULTANEOUSLY
THIS WILL BACK SPACE YOU & ALLOW YOU TO OVERWRITE CHARACTERS
IF YOU WISH TO STOP ANYWHERE TYPE IN -- STOP

TYPE IN THE QUARTER & YEAR DESIRED FOR INDEX CALCULATION
ENTER THESE AS - 1 1976 - TO INDICATE THE 1ST QUARTER OF 1976
(DONT TYPE IN THE -), VALID YEAR CHOICES ARE 1975-1981
THE INDEX IS BASED ON 1967=100
I>4  1981

TYPE IN USER LEVEL, TYPE IN -E- FOR EXPERT USER
THIS ALLOWS YOU TO TYPE ALL INPUTS WITHOUT DETAILED WORDING
IF NOVICE USER TYPE ANY CHARACTER OTHER THAN E
I>e

TYPE IN, ON 1 LINE, PROJ NO., PROJECTED QUARTER,
PROJECTED YEAR, & ON NEXT LINE, SKIP IF SKIP OPTION DESIRED

I>22    4   1984
I>skip
```

Figure 4. Output for COSTIND option 4.

```
TYPE -PIE- IF PIE CHART COMPARISION OF 19 PROJECT
INDICES DESIRED (TIME CONSUMING ON NON GRAPHICS TERMINALS)
OTHERWISE TYPE IN ANY OTHER CHARACTER.

I>nopie

 CONSTRUCTION COST INDICES FOR QUARTER  4   OF YEAR  1981


  THE PROJECT INDICES FOR QUARTER  4 OF YEAR  1981
   1  03    RESERVOIR              330.694
   2  04A   EARTH DAM              314.247
   3  04B   CONCRETE DAM           309.639
   4  05    LOCK                   311.655
   5  07    POWER PLANTS           305.466
   6  08A   ROADS                  317.333
   7  08B1  CONCRETE BRIDGE        310.092
   8  08B2  STEEL BRIDGE           317.614
   9  08C   RAIL ROAD              317.466
  10  09A   CHANNELS & CANA        311.558
  11  09B   CHANNELS & CANA        324.230
  12  10    BREAK WATERS           322.026
  13  11A   LEVEES                 311.476
  14  11B   LEVEES                 327.776
  15  11C   LEVEES                 321.598
  16  13    PUMPING PLANTS         311.175
  17  15    FLOODWAY CONTRO        312.444
  18  16A   BANK STABILIZAT        296.614
  19  16B   BANK STABILIZAT        302.107


    PAUSE   TO CONTINUE TYPE- GO, TO STOP TYPE- STOP
I>go
```

Figure 4. (Cont'd).

LINEAR PROJECTIONS FOR QUARTER 4 OF YEAR 1984

1	03	RESERVOIR	408.631
2	04A	EARTH DAM	389.882
3	04B	CONCRETE DAM	377.379
4	05	LOCK	382.995
5	07	POWER PLANTS	383.936
6	08A	ROADS	394.100
7	08B1	CONCRETE BRIDGE	377.782
8	08B2	STEEL BRIDGE	388.331
9	08C	RAIL ROAD	377.469
10	09A	CHANNELS & CANA	398.111
11	09B	CHANNELS & CANA	408.150
12	10	BREAK WATERS	410.467
13	11A	LEVEES	386.234
14	11B	LEVEES	413.664
15	11C	LEVEES	396.909
16	13	PUMPING PLANTS	378.329
17	15	FLOODWAY CONTRO	378.783
18	16A	BANK STABILIZAT	379.041
19	16B	BANK STABILIZAT	380.457

```
   PAUSE   TO CONTINUE TYPE- GO, TO STOP TYPE- STOP
I>go
*
C>
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Figure 4 (Cont'd).

APPENDIX:

CWCCIS AND THE PRINCIPLES OF COST INDEXING

CWCCIS provides national cost indices specific to 19 major construction types, or "features" (Table A1). The feature indices are computed from three levels of subindices, which provide increasing detail (Figure A1). The first level below the feature consists of indices for five primary categories of work — earthwork, concrete, steel, mechanical, and electrical — and a secondary category, buildings. The third level breaks each category into labor, plant, and material resource classes. The most specific level provides indices for the actual types of resources used in the construction for each resource class.

For CWCCIS, indices were not developed for each resource type; rather, key indicators containing resources whose index values change at the same rate were chosen to provide a manageable number of indicators, yet still account for most of the cost for a particular feature. Any remaining resource types, each of which contributed less than 1 percent of the costs, were placed in the "Other" category (Figure A1). To develop the system, more than 80 detailed Government estimates were analyzed. The resources were weighted according to their importance to a specific project. Thus, a resource that is not needed to build a dam, for example, is not considered in an index provided to the user who is figuring costs for a dam. This feature of the system makes the cost figures far more accurate.

This appendix outlines the principles of indexing and explains the importance of weighting schemes in calculating index numbers.

Index Numbers

An index number is a ratio between the cost of a resource or composite of resource costs at one period of time and the cost of the same resource or composite at a specific previous date or period called the base period (or base year). The index number thus indicates the percent change in cost that has resulted from inflation between the base period and the later date.

For example, assume that in 1967 1 cwt of cement cost $1.20 and that in 1976 the cost was $2.53. If 1967 is taken as the base year, then the index value for a cwt of cement in 1976 is:

$$\frac{2.53}{1.20} = 2.108$$

or as it is usually expressed, 210.8. This index value indicates that from 1967 to 1976 the cost of a unit of cement rose 2.108 times.

There are two types of index numbers: simple, consisting of a single commodity, and composite, comprising several different commodities. The example above is a simple index.

Table A1

Features for Which Indices Were Developed

1. Reservoirs
2. Dams, earth
3. Dams, concrete
4. Locks
5. Power plants
6. Roads
7. Concrete bridges
8. Steel bridges
9. Railroads
10. Channels and canals
    (Based on estimates containing only earthwork job items)
11. Channels and canals
    (Based on estimates containing both earthwork and concrete work. This feature provides for concrete lining, concrete slope protection and drainage systems in addition to the earthwork found in feature 10.)
12. Breakwaters and seawalls
13. Levees and floodwalls
    (Based on estimates for levees with heaped earth with aggregate or riprap slope protection)
14. Levees and floodwalls
    (Based on combination of levees and floodwalls that have structural concrete work including walls or slope protection)
15. Levees and floodwalls
    (Based on estimates that have levees, floodwalls, and floodgates and contain all five primary categories of work)
16. Pumping plants
17. Floodway control and diversion structures
18. Bank stabilization
    (Based on estimates with only earthwork category)
19. Bank stabilization
    (Based on estimates with large amounts of riprap slope protection and major drainage systems)

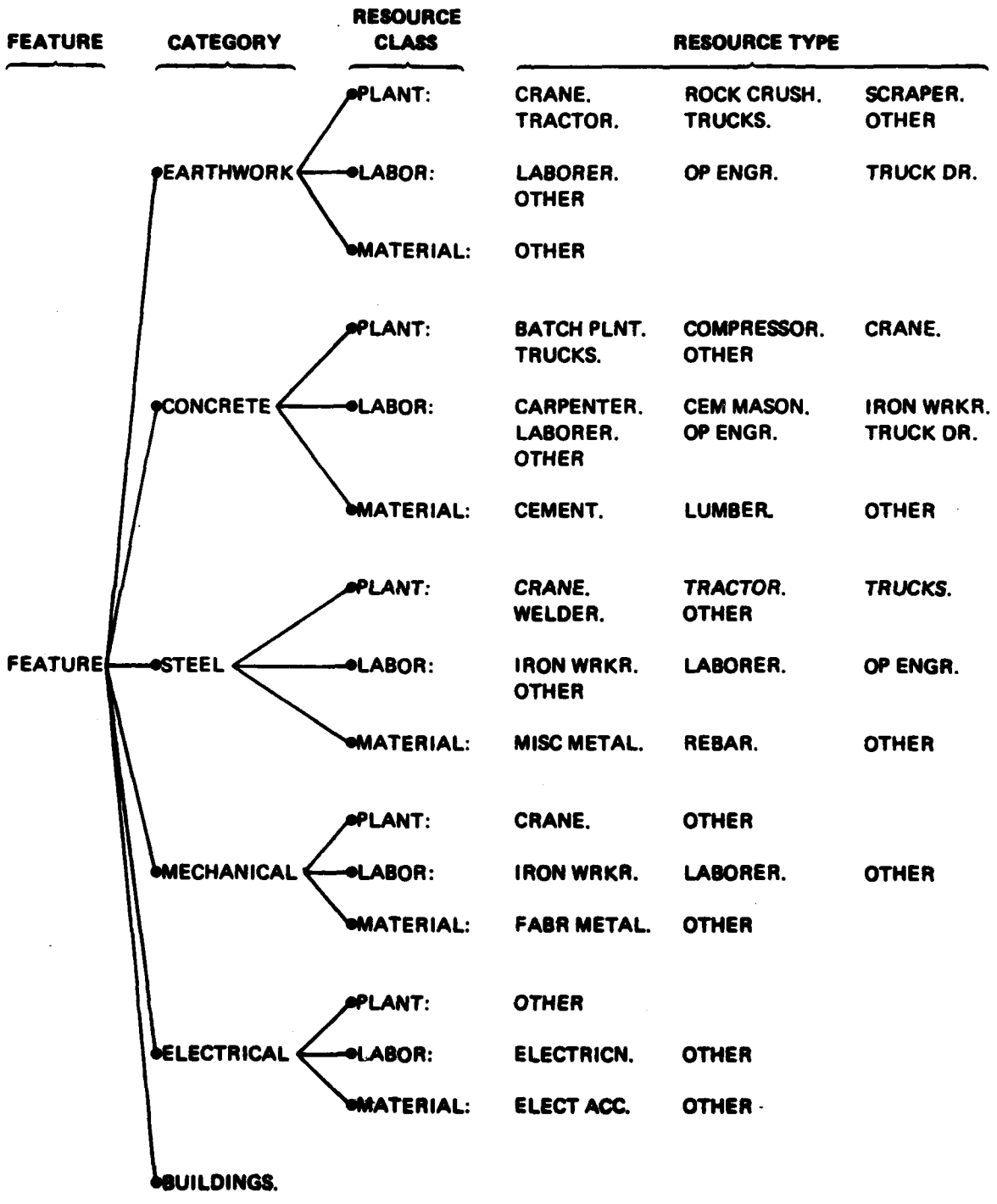

Figure A1. Hierarchy of levels in CWCCIS.

Composite indices are more difficult to construct and interpret than simple indices. Nevertheless, only composite indices, with which this report is concerned, yield useful insights into cost inflation.

There are three problems in index number construction:

1. Selection of items to be included. Over 2000 items are purchased for a typical building project. The Bureau of Labor Statistics measures only about 400 of these goods and services, which reflect the average change in the entire construction project.

2. Choice of a base period from which to calculate change in prices. Whatever the date chosen, the level of prices in the base period is taken as 100. The further away one moves in time from the base period, the dimmer one's recollection of the conditions prevailing; consequently, bases are shifted periodically to more current time periods.

3. Selection of weights to be used. Since the individual items included in the index are not equally important, weighting schemes are usually applied to give each item its proper influence in the index number calculation. For example, the cost of nails is usually not as important a share of total costs as labor. Consequently, changes in labor costs should carry greater weight than nails in cost index calculations.

Weighting

The problems of weighting can be illustrated by creating a simplified composite construction price index for the period 1980 to 1981. Assume that the index has only four components -- labor, nails, lumber, and paint -- and that in 1980 and 1981 the costs of these four materials were as shown in Table A2.

A crude composite construction cost index could be constructed by simply totaling all the resource costs in each year, taking the ratio of these totals, and multiplying by 100. This is to say,

$$\text{Construction cost index} = \frac{26.50}{20.50} \times 100 = 129.3.$$

This index means that the same commodities and services purchased in 1980 would cost 29.3 percent more if purchased in 1981.

Suppose that another commodity is added to this cost index -- gold faucets. The revised figures are shown in Table A3. Now the construction cost index reads:

$$\frac{426.50}{620.50} \times 100 = 68.7,$$

representing a decline in cost of 31.2 percent. The point is this: the overall index declined even though the price of four of the commodities increased and only one declined. Moreover, the higher priced commodity was one which is very unimportant in the budgets of most construction projects.

Table A2

Costs of Four Construction Inputs

	1980 Cost	1981 Cost
Labor (1 hr)	$7.00	$8.50
Nails (1 box)	2.50	3.50
Lumber (1 2x4)	5.00	6.50
Paint (1 gal)	6.00	8.00
Total:	$20.50	$26.50

Table A3

Costs of Five Construction Inputs

	1980 Cost	1981 Cost
Labor (1 hr)	$7.00	$8.50
Nails (1 box)	2.50	3.50
Lumber (1 2x4)	5.00	6.50
Paint (1 gal)	6.00	8.00
Gold faucets (1 faucet)	600.00	400.00
Total:	$620.50	$426.50

This implies that commodities included in an index must be weighted by their relative importance to the project.

Another deficiency of this type of index is the arbitrary nature of the units on which the prices are based. For example, Table A4 shows the figures if the price of labor were stated in terms of per minute rather than per hour. So the cost index would read:

$$\frac{18.14}{13.62} \times 100 = 133.2,$$

instead of 129.3.

The results shown in Tables A3 and A4 indicate that a reasonable weighting scheme must be adopted. This would take into account the relative importance of each item and would insulate the index from arbitrary differences in units of measure. For a construction cost index, reasonable weights would be given by the usual amounts of the commodity purchased for a typical construction project. These are called "quantity" weights, since they represent quantities of goods or services purchased.

Table A5 is an example of such a weighting scheme. It assumes that 1 hr of labor, three boxes of nails, two 2 x 4 boards, and 1 gal of paint were used for the "typical" construction project built in both 1980 and 1981. The two columns on the right show the 1980 and 1981 prices of these inputs multiplied or "weighted" by these quantities. These two weighted columns provide the bases for the construction cost index.

The construction cost index using weighted prices is thus:

$$\frac{40.00}{30.50} \times 100 = 131.1$$

This figure more accurately reflects construction cost inflation because each of the materials is weighted according to its relative importance in a construction project. Note that if the units in which the commodities are measured change, the weights also change to compensate.

The general formula for this type of index (called a Laspeye index) is:

$$\frac{\Sigma Pn \cdot Qo}{\Sigma Po \cdot Qo} \times 100 \qquad \text{[Eq A1]}$$

where: Po = price in base period
Pn = price in non-base period
Qo = quantity in a base period.

This is the formula used by CERL's Civil Works construction cost index, which attempts to measure how much it would cost (at retail) to purchase the goods and services needed to build a typical Civil Works project, compared with what it would have cost in a base period. The quantity weights used in this index were derived from a careful survey in 1980 of the goods and

services used for representative Corps projects. The items measured are listed in Table A6.

New construction techniques eventually may be developed and commodity prices may change. Cheaper substitutes may be found for expensive materials or altogether new materials may be introduced into the construction process. Thus, the relative importance of individual products and services changes over time, and weights must be periodically updated. Fortunately, engineering principles and techniques do not change as rapidly as prices, so the weights should not have to be re-examined or resurveyed more than once every 5 or 10 years. In fact, a single resurvey in 1990 may be adequate if technological changes in civil works construction are moderate enough, and if limited budgets prevent more frequent surveys. Projects used in a resurvey should be randomly selected so that accurate inferences can be drawn for all Corps construction projects. The price information used by the computerized CWCCIS is subject to much greater variability, and therefore is updated more frequently by the Office of the Chief of Engineers.

Table A4

Costs of Four Construction Inputs — Price of Labor in Minutes

	1980 Cost	1981 Cost
Labor (1 min)	$0.12	$0.14
Nails (1 box)	2.50	3.50
Lumber (1 2x4)	5.00	6.50
Paint (1 gal)	6.00	8.00
Total:	$13.62	$18.14

Table A5

Quantity Weighting Scheme

	1980 Cost	1981 Cost	1980 Quantity	1980 Cost x Quantity	1981 Cost x Quantity
Labor (1 hr)	$7.00	$8.50	1 hr	$ 7.00	$ 8.50
Nails (1 box)	2.50	3.50	3 boxes	7.50	10.50
Lumber (1 2x4)	5.00	6.50	2 pieces	10.00	13.00
Paint (1 gal)	6.00	8.00	1 gal	6.00	8.00
			Total:	$30.50	$40.00

Table A6

Items Surveyed to Derive Quantity Weights

Labor	Plant	Material
Carpenter	Compressor	Cement
Cement mason	Crane	Electrical
Electrician	Mixer, paver	Explosives
Ironworker	Rock drill	Fabricated metal
Laborer	Scraper-grader	Lumber
Operator	Special machine	Miscellaneous metal
Painter	Tractor	Rebar
Plumber	Trucks	Aggregate
Truck driver	Welding equipment	Steel plates
Other labor	Other plant	Machinery
		Turbines
		Mattress
		Other material

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